Umaltra, W.H

CIRCULAR 140

Potato Growing in New Jersey

IMPERIAL BUREAU OF MYCOLOGY
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A Typical Scene on a New Jersey Potato Farm in Late June

Almost 100,000 Acres in New Jersey Devoted to this Crop Give an Annual Yield of Ten to Fifteen Million Bushels.

NEW JERSEY
AGRICULTURAL EXPERIMENT STATIONS

NEW BRUNSWICK, N. J.
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POTATO GROWING IN NEW JERSEY

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Introduction

Probably no New Jersey farmers as a class have made a more thorough study of their problems than the potato growers. They have made great strides in the growing of their crop through the use of high-grade fertilizers, the planting of vigorous seed, thorough cultivation and the adoption of insect and disease control measures. As a result they are as progressive as any other group of men similarly engaged.

In 1921 New Jersey ranked twelfth among the states in the production of potatoes. The acreage of potatoes has shown a steady increase from year to year until now it is one of the most important crops grown in the state. In 1897, 1.9 per cent of the improved land, amounting to 41,600 acres, was planted in potatoes. By 1921, this had increased to 95,000 acres, or 6.1 per cent of the improved land. The average yield in 1921 was 95 bushels per acre, and the crop had a total farm value of $12,816,000. It is questionable if the increase in acreage noted from year to year in the past will continue, because the area of soils most desirable for potato growing is limited. The proximity of the important potato-growing sections to the world's greatest markets, however, ensures the continuance of the potato as one of the leading crops of the state.

The acreage planted in potatoes, together with the total production and the average yields for the different counties for the years 1909 to 1919, is given in table 1. It will be noted that the yields varied from 50 to 168.4 bushels per acre. Not only was there this difference in yield in the various counties of the state, but the same variation exists within the counties. In Monmouth County, with an average yield of 168.4 bushels per acre in 1919, a yield of 300 to 350 bushels is by no means uncommon. It is therefore apparent that some growers are procuring a yield considerably less than the average for the county.

Note: The author desires to acknowledge the courtesy of the following for contributing illustrations for this circular: William B. Duryee for figures 3, 4 and 5; J. C. Crissey for figure 2; and Minch Brothers for figures 7 and 10.

TABLE I

ACREAGE AND YIELD OF POTATOES FOR THE VARIOUS COUNTIES OF THE STATE IN 1909 AND 1919

County	1919			1909		
	Acres	Total Yield	Average Yield	Acres	Total Yield	Average Yield
		bu.	bu.		bu.	bu.
Atlantic	1,473	91,999	62.4	838	65,561	78.2
Bergen	519	25,907	50.0	1,297	84,018	64.7
Burlington	8,228	707,446	85.9	9,115	1,073,371	117.7
Camden	2,913	329,657	109.7	3,004	323,372	107.6
Cape May	1,372	96,045	70.0	847	73,932	87.2
Cumberland	5,680	605,009	106.5	5,739	647,415	112.8
Essex	184	10,086	54.8	316	24,056	76.1
Gloucester	6,532	742,007	113.0	7,149	876,274	122.5
Hunterdon	842	48,695	57.8	950	66,663	70.1
Mercer	8,168	1,173,562	143.6	5,479	556,729	101.6
Middlesex	6,468	867,218	134.0	4,845	475,807	98.1
Monmouth	24,859	4,177,438	168.4	14,784	1,893,523	128.0
Morris	1,074	68,337	63.6	1,910	117,225	61.3
Ocean	835	59,637	71.4	758	59,875	78.9
Passaic	431	34,894	80.9	743	46,198	62.1
Salem	9,033	1,032,926	114.3	10,111	1,303,088	128.8
Somerset	659	41,172	62.4	833	58,372	70.7
Sussex	1,001	50,764	50.7	1,222	96,913	79.3
Union	201	11,566	57.5	438	17,748	40.5
Warren	2,061	144,941	70.3	2,613	197,264	75.4

It is difficult to ascribe any one cause for the differences in yields existing between the various counties and between individual growers in the same county. Any one or all of the following factors no doubt function in bringing about this difference. Probably one of the most important factors contributing to low yields is the fact that in some instances potatoes are grown on soils not adapted to the crop. Other factors of importance that contribute to low yields are a deficient soil moisture content, failure to fit the land properly, failure to study the fertilizer requirements of the crop on the particular soil, the use of insufficient fertilizer, the use of culls or other low-grade seed, failure to cultivate thoroughly or inability to cultivate adequately on account of too large an acreage, failure to protect the growing plant from insects and from diseases.

The purpose of this circular is to discuss briefly the means whereby the losses resulting from the above-mentioned causes may be reduced. It is true that a more general adoption of tried and approved practices of fertilization, cultivation and crop protection in those sections where potato growing is less extensively practiced would doubtless lead to an increased yield for the state. This discussion will be

limited to the commercial crop. The methods followed in growing the late crop for seed will be taken up in a future publication.

Soil Requirements

While the potato may be grown on a wide range of soils, varying from light to heavy, for maximum yields, the range is fairly limited. Too much importance cannot be attached to the question of the soils best adapted to the crop, since it is probably true that the physical condition of the soil is equal in importance to its fertility. The influence of soil type on tuber production is apparent from results obtained in Colorado.[1] On a heavy clay soil, the Rural New Yorker

FIG. 1.—GETTING READY FOR THE COVER CROP; A GOOD COVER CROP IS IMPORTANT IF MAXIMUM YIELDS ARE TO BE OBTAINED

variety produced 3.1 tubers per hill, on a clay loam, 4.2 tubers and on fine sandy loam 5.9 tubers. The results indicate clearly that an increase in productivity of the potato can be expected as the character of the soil changes toward the lighter types. The most desirable soil for potato growing is deep, easy to work, well drained, supplied with sufficient moisture and rich in humus.

On heavy soils, the crop is likely to be small and the tubers misshapen, arising from the fact that there is little free access of air and from the difficulty of maintaining a proper moisture supply. A heavy soil, however, frequently can be converted into a good potato soil

[1]Clark, C. F., 1921. Development of tubers in the potato. U. S. Dept. Agr., Bul. 958.

by plowing under organic matter. One of the most important means of maintaining the necessary moisture content in the soil is sufficient humus. This is just as true of a light soil as of the heavy soils. Humus in light soils holds the soil particles together and thus increases the water-holding capacity. In a heavy soil, humus tends to separate the soil particles and by increasing the pore space increases the water-holding capacity. Decaying organic matter also allows better aëration, thus permitting more favorable conditions for root development as well as for the activity of desirable soil organisms.

The humus content of the soil may be increased by plowing under clover, alfalfa, vetch, oats, wheat or rye. The last three mentioned are probably the more desirable where the only requirement is that the humus content be increased, since these plants are succulent and decay rapidly. From the standpoint of eradicating the scab organism from the soil, the use of rye, sown at the rate of 1½ to 2 bushels per acre, may be expected to give better results than either of the other two.

Good drainage also is of considerable importance in the production of a maximum crop. If the land is not naturally drained, it should be artificially drained. An excess of water not only excludes the air but prevents the development of many necessary bacteria. In addition, the presence of excessive quantities of water frequently results in the rotting of the seed-piece.

Crop Rotation

No definite recommendations can be made concerning the crops to be grown in rotation with potatoes which could be adopted in all sections of the state. This must be largely determined by local practices and conditions. In Central Jersey a favorite rotation and one that has proved to be very successful, is potatoes, wheat or rye seeded with timothy and clover the second and third years, and corn the fourth year. In other cases potatoes are planted for one, two or three years, followed by grass for two and sometimes three years and corn for one year.

In many of the most important potato-growing sections of the state no rotation is practiced; potatoes being grown year after year on the same land. It is questionable if this is a good practice. Experience has taught that certain diseases increase in severity from year to year and this is particularly true of scab. In some instances this trouble has become so severe as to make it impossible to grow a clean crop. Where the scab organism is present in the soil, it would be advisable to devote the land to some other crop. If this is done

for a few years and green manures are plowed under the amount of scab should be greatly reduced.

Not only is there this tendency toward an increase in disease, but the continual growing of potatoes on the same land has a deleterious effect on its physical condition. In some instances in Central Jersey it has been observed that where the continuous growing of potatoes is practiced, the soil is inclined to harden, a condition by no means desirable for potatoes. In view of these facts, there is no question of the advisability of growing potatoes in rotation with other crops.

Plowing and Fitting the Land

In most sections of New Jersey, the land is plowed in early spring, as soon as possible after the frost is out of the ground. Where the subsoil is heavy or where a heavy sod is to be turned under, fall plowing is probably more advisable than spring, since the upturned soil is exposed to the weathering agencies during the winter months. The land should be plowed as deep as possible, according to the depth of the surface soil as well as the depth to which it has previously been plowed. It is usually advisable not to turn up more than ½ or 1 inch of the subsoil. In Monmouth County the best growers plow at least 9 inches.

The preparation of the seed-bed is of extreme importance. As soon as fit the soil should be worked with a cutaway or disc harrow. When properly used this implement cuts up both the surface and the lower layers of soil. Preparation of the seed-bed should not be considered complete until all lumps are thoroughly broken up and the soil is leveled off and is compact. Fitting the seed-bed is one of the most important operations in the successful production of potatoes. A well prepared seed-bed not only allows for the production of a large crop but leads to a decrease in costs, since a thorough pulverizing of the soil tends to inhibit the development of the weeds and thus lightens subsequent cultivations.

Plow early, as deep as conditions permit and firm the land as well as possible before the crop is planted. These operations will save time after the crop is up.

Fertilizing the Crop

If maximum yields are to be obtained serious consideration must be given to the question of the kind and amount of fertilizer to use. This is determined somewhat by the type of soil and the previous crop grown. If potatoes follow a legume it is probably unnecessary to use as much fertilizer as where potatoes follow potatoes. In the sections of the state where intensive potato growing is practiced,

an application of 1 ton or even 2400 pounds of a high-grade fertilizer is the adopted practice. In other sections as little as 600 pounds is used. The tendency among New Jersey growers is toward greater fertilizer applications, resulting no doubt in part from the fact that the depth of the potato land is being increased, as is also the humus content, which in turn gives the soil a greater water-holding capacity. Heavy applications of fertilizer are more likely to give maximum returns on soils of this kind.

While chemical fertilizers are used almost entirely in the larger potato-growing sections of the state, in some localities farm manures are used extensively. A 10-ton application of well preserved farm manure supplies sufficient plant-food to produce a crop. In order to produce a maximum crop, however, it is necessary that the manure be supplemented by commercial fertilizer. This may be done by applying 600 pounds of a 2-12-2 mixture, that is, a mixture containing 2 per cent of ammonia, 12 per cent of phosphoric acid and 2 per cent of potash. This should be applied in the row at the time of planting. The use of farm manure on land that shows any tendency to grow a scabby crop is not advisable. This disease, one of the most serious troubles of the potato crop in New Jersey, is frequently very severe following applications of manure. If manure is to be used as a fertilizer for potatoes it is advisable that it be applied as far ahead of the potato crop as is possible.

In studying the question of the kind and amount of fertilizer to use, the following points should be considered: (1) The source or sources and amount of nitrogen which will give the best results; (2) the source and quantity of potash which will give the best results; (3) the importance of using a properly balanced mixture; and (4) the proper amount of fertilizer to apply. The New Jersey Agricultural Experiment Station, in co-operation with the Bureau of Soil Fertility Investigations of the United States Department of Agriculture, has been conducting investigations on these questions for the past three years. The results are discussed briefly here.

Source and Amount of Nitrogen

The nitrogen sources may be either organic, such as fish, tankage, dried blood and cottonseed meal; or inorganic, as nitrate of soda and ammonium sulfate. In most of the tests conducted during the past three years, nitrate of soda as the only source of nitrogen outyielded any of the others used alone. Ammonium sulfate did not give as good results as the nitrate, but when these two were used in combination the results were exceptionally good. The indications

are that from the standpoint of crop returns the inorganic materials are more satisfactory than the organic.

There are other factors to be considered, however, in deciding on the kind of ammoniate to use. If the fertilizer mixture is prepared some months ahead of the planting operation, it is necessary that a portion of the ammonia be derived from the organic ammoniates in order to prevent caking and to promote ease in drilling. Also, since the organic ammoniates are less soluble and consequently less readily available to the plant than the inorganic, they ensure a more uniform distribution of nitrates to the plant over the season of growth. For these reasons a mixture in which one-third of the ammonia is derived from nitrate of soda, one-third from ammonium sulfate and one-third from one of the organic materials would probably be more advisable than a fertilizer in which all of the ammonia is from inorganic sources. Furthermore, in soils where there is a tendency for the crop to scab, the use of nitrate of soda as the only source of ammonia will unquestionably lead to an increase in the trouble. On the other hand, ammonium sulfate which tends to make the soil acid, should lead to a decrease in the amount of scab. The mixture indicated above, with the ammonia derived from all three sources, should have a tendency to reduce the amount of scab.

For early potatoes such as the Irish Cobbler, best results usually follow where 5 to 6 per cent of ammonia is used. For the late varieties this may be reduced to 4 and possibly to 3 per cent. Where potatoes are to follow a legume, the use of 3 per cent is probably more advisable than the larger amount, since an excess of nitrogen is likely to lead to the production of large vines and low yields.

Source and Amount of Potash

In our fertilizer experiments various sources of potash, including the sulfate and the muriate, were tested. It has been fairly well established that sulfate of potash produces potatoes of better quality than the muriate. The latter seemingly interferes with the formation of starch and leads to the production of a waxy potato. On the other hand, muriate of potash has given better yields in many cases than the sulfate, and this, together with the fact that it is a cheaper source of potash, possibly makes its use preferable to that of the sulfate.

In past years it was customary in New Jersey to use a fertilizer carrying 10 per cent of potash. The result of the fertilizer tests conducted in various parts of the state and on different soil types indicate that maximum yields will result with considerably less. In

most of the tests, when the amount of potash was increased to more than 5 per cent, there was a tendency toward a falling off in yield. From the result of the tests it is questionable if the use of more than 5 or 6 per cent is advisable.

Balanced vs. Unbalanced Mixtures

In the experiments mentioned, comparisons were made of balanced and unbalanced mixtures. In every case the mixtures employed contained the same number of units of plant-food but in different proportions. In every instance the mixtures which contained the three fertilizer ingredients in proper proportions gave a greatly increased yield over the unbalanced mixtures.

In New Jersey for the Irish Cobbler varieties a 5-8-5 mixture (5 per cent of ammonia, 8 per cent of phosphoric acid, and 5 per cent of potash) can be expected to give best results. For the American Giant and Green Mountain varieties a 4-8-5 mixture under average conditions should give maximum returns.

Amount to Apply

The amount of fertilizer to apply must be determined largely by local conditions. As a result of our tests it is questionable if any amount over 1 ton per acre will give returns commensurate with the amount of fertilizer used. In most of the tests when the application was increased over this amount there was a falling off in yield. Under ordinary conditions an application of 1600 to 2000 pounds of a mixture such as is indicated above should give maximum yields.

Method of Application

In most instances the fertilizer is applied at the time of planting by means of a fertilizer-distributing attachment on the planter. Usually all of the fertilizer is put in at the time of planting. Some growers have advocated that part of the fertilizer be applied in the row at planting and the remainder side-dressed when the plants are up. Some work was done on this question on the late crop in 1921 with the following results. Where all of the fertilizer was applied in the row, the yield was 182 bushels per acre as compared with 198.8 bushels where part of the application was made in the row and part as a side-dressing when the plants were about 6 inches high. It is questionable if the slight increase obtained would repay the extra labor involved.

Work of a similar nature conducted at the Connecticut Agricultural Experiment Station at Storrs,[2] over a period of four years,

[2]Slate, W. L., Jr., and Brown, B. A., 1920. Fertilizers for potatoes. Conn. (Storrs) Agr. Exp. Sta., Bul. 106.

showed that where fertilizer was applied at the rate of 2000 pounds in one treatment the yield was 252 bushels per acre as compared with 246 bushels where a like amount was applied in two treatments, half at the time of planting and the remaining half when the plants were 6 to 10 inches high. From these results it appears that when properly applied a treatment of 2000 pounds of high-grade fertilizer may be made in the row without danger of injuring the seed-piece.

In this connection, the importance of the position of the fertilizer in relation to the seed-piece should be noted. In work conducted at the New Jersey station, Coe[3] applied fertilizer in four different positions in relation to the seed-piece, as follows: (1) In direct contact with the seed-piece, (2) 1 inch above, (3) 1 inch below, and (4) 1 inch to the side. Injury resulted in all the direct-contact rows —the seed-piece either failed to germinate or the development of the plant was greatly retarded. Best results were obtained where the fertilizer was applied in the lower plane along the sides of the seed-piece and separated by one or two inches of soil.

Placing the fertilizer above the seed resulted in a low yield in dry weather because the roots were unable to reach it. In wet weather the yield was better since the fertilizer was leached down to the roots. The yields per acre from the various treatments follow:

Fertilizer in direct contact with the seed-piece—132 bushels.
Mixed with the soil in the row—152 bushels.
Above the seed with the soil separating—128 bushels.
At sides of seed and on the same plane—173 bushels.
At sides of seed but on lower plane—206 bushels.

From these results the necessity of property adjusting the fertilizer distributing attachments on the planter is apparent.

Home Mixing

The biggest single item in the cost of growing potatoes in New Jersey is the fertilizer bill. In 1919 in Monmouth County this amounted to $59.07 per acre, and although reduced to $49.22 in 1921, it still amounted approximately to one-third of the entire cost of growing the crop. Many of the New Jersey growers have effected a big saving in their fertilizer bill by mixing their own fertilizers. While it is questionable if as big a saving can be effected with the present prices of ready-mixed goods, the grower who mixes his own fertilizer has the satisfaction of knowing just what ingredients are

[3]Coe, D. G., 1922. Fertilizing the potato crop. What is the best method? Hints to Potato Growers, vol. 2, no. 10.

included. Several formulas that have been used by different growers and have given good results are presented here:

Formula I

Nitrate of soda.....200 lbs.	This makes a 5-10-6 mixture, a good mixture for the Irish Cobbler variety.
Ammonium sulfate.....150 lbs.	
Tankage, 9 per cent.....200 lbs.	
Fish .....100 lbs.	
Acid phosphate .....1,100 lbs.	
Muriate of potash.....240 lbs.	

Formula II

Nitrate of soda.....200 lbs.	This combination contains 4 per cent of ammonia, 8 per cent of phosphoric acid and 6 per cent of potash.
Sulfate of ammonia..... 80 lbs.	
Tankage .....300 lbs.	
Acid phosphate.....1,000 lbs.	
Muriate of potash.....240 lbs.	

Where scab is prevalent the amount of nitrate of soda might be decreased with an increase in the ammonium sulfate. The mixture below is a 4-8-5.

Formula III

Nitrate of soda.....100 lbs.
Ammonium sulfate.....125 lbs.
Tankage .....300 lbs.
Acid phosphate.....1,000 lbs.
Muriate of potash.....200 lbs.

How to Purchase Raw Materials

When the grower decides to mix his own fertilizer there are certain points he must keep definitely in mind.

1. Buy only standard materials carrying available plant-food or plant-food which is made available after the material has been mixed with the soil for a reasonable length of time. Other things being equal, the readily available materials are to be preferred, since it has been shown that the returns from these materials are usually larger than from an equivalent amount of those that are more slowly available.

2. Note carefully the difference in the unit price of the different nitrogenous materials. Quotations on raw materials frequently give the unit cost of ammonia in the different raw materials. (A unit of ammonia is the number of pounds of ammonia in each 100 pounds of the raw material). If the unit price is not quoted the price per pound may be calculated if the analysis of the material and the cost per ton are given. For example, nitrate of soda, analysing 18½ per cent ammonia (18½ lbs. of ammonia per 100 lbs. of material) carries

370 pounds of ammonia in a ton. If nitrate is selling at $44.00 per ton, the ammonia in this is costing approximately 12 cents per pound. The cost of a unit of ammonia in the other ammonia carriers may be determined in a similar manner.

3. See that all raw materials are in good mechanical condition. Acid phosphate especially must not be wet and sticky.

4. The materials must be such that when properly mixed they will work readily in the drill. A good fertilizer is of little value if it cannot be distributed. From the standpoint of availability and crop returns, it would be desirable to take all or nearly all of the ammonia from nitrate of soda and sulfate of ammonia, each furnishing about one-half of the total. This is impossible, however, since a certain amount of organic material (or some substitute) must be used as a mechanical conditioner.

Varieties

The question of which variety to plant must be decided largely by soil conditions and by the demands of the market. The successful grower will determine the variety that does best under his conditions, and having found it will grow it to the exclusion of other varieties, since it is probably true that no two behave alike under the same conditions.

In some sections of North Jersey, the Rural group and particularly Dibble's Russet is grown successfully. This variety yields well, is resistant to drought and the tubers are of good shape and quality.

In Central Jersey the Irish Cobbler, Green Mountain and American Giant varieties are extensively grown, the latter predominating in many localities. The popularity of the American Giant variety in the past arose from the fact that it outyielded the other varieties and was considered to be more resistant to scab. For several reasons there is a growing tendency however, to plant more Irish Cobblers and Green Mountains and fewer American Giants. Variety tests conducted for several years past have indicated that the Irish Cobbler and Green Mountain varieties will give approximately as heavy yields as the American Giant. Furthermore, the selling price of the American Giants is lower than that of the other two, so that an increase in yield in favor of the former is often wiped out by the difference in price. While it is true that this variety appears to scab less readily than the others, it cannot be said to be resistant, for in recent years whole fields of American Giants have been observed in which nearly all of the tubers were unsalable on account of scab.

In South Jersey the Irish Cobbler variety is grown almost entirely for the early crop. In some of the southern counties the Jersey Red

Skin, the Pink Eye and the Superba are planted, usually about the middle of July, for the late crop.

Source of Seed

In the sections of New Jersey where potatoes are grown intensively considerable attention is given to the question of seed. The growers realize that planting low-grade seed potatoes will result in low yields regardless of the amount of fertilizer used or the care taken in cultivation. In some sections, however, this question does not receive serious consideration. In many cases the culls from the

Fig. 2.—The Rows to the Right Were Planted with Vigorous Seed, Those to the Left with Low-Grade Seed; Which Rows Will Pay the Fertilizer Bill?

previous year's crop or other low-grade seed is used. The potato grower cannot afford to economize on his seed; poor seed is costly at any price. This is apparent from the results of comparative tests conducted with seed saved from the previous year's crop and with northern seed. The former yielded at the rate of 140 bushels per acre as compared with 230 for the latter.

More attention is now being given to the production of high-grade seed potatoes than at any time in the past. In answer to the demand for vigorous, disease-free seed stock, most of the important seed-producing sections have inaugurated a system of inspection and certification. To be certified the crop must conform to certain standards with regard to the amount of disease, trueness to type and vigor. In New Jersey, fields entered for certification, are inspected three times, twice during the growing season and again when the crop is

dug. As a result of the extra cost of growing the crop, certified seed usually sells at a slight advance over non-certified seed. This difference in price is usually offset by increased yields. In tests conducted in 1921 certified seed yielded at the rate of 129 bushels per acre as compared with 88 bushels per acre for seed which had not been certified—a distinct difference in favor of the certified seed.

In years past the great bulk of the seed potatoes planted in New Jersey came from Maine and New York State. In recent years considerable seed has come in from other sources. The Monmouth County Farmers' Exchange reports that seed purchased by them for the Monmouth County growers for the 1922 planting came from the following sources, 59 per cent from Maine, 15 per cent from New Jersey, 14 per cent from New York, 10 per cent from Virginia and 2 per cent from Kentucky. In South Jersey, particularly in Salem and Cumberland counties, the proportion of Jersey-grown seed planted is much higher; in fact most of the seed used is from home sources. South Jersey has but recently entered the field of seed production and the seed grown in this section has proved to be of high vigor. This industry has shown a steady development, as is evidenced by the fact that 908 acres were entered for certification in 1921 as compared with 177 acres in 1920 and 153 in 1919.

Storage of Seed Potatoes

It sometimes happens that high-grade seed potatoes, purchased in the fall, have their vigor impaired through improper storage. Storage cellars should be dry and well ventilated. The temperature relation also is important; the temperature should be maintained as close to 33° to 36° F. as possible. Higher temperatures will cause the tubers to sprout too early.

Seed potatoes should be stored in crates or slatted barrels, since these may be piled in such a way as to allow for proper ventilation. If potatoes are to be stored in bulk they should not be piled deeper than five or six feet. When piled to a greater depth those at the bottom very frequently sweat and are readily attacked by organisms causing rot. In other instances the interior of potatoes at the bottom of the pile frequently turn black, very often rendering them unfit for seed.

Cutting the Seed

In some sections of New Jersey, seed potatoes are cut by machine. When labor is high, this might prove advisable but with low labor costs, it is questionable if any saving can be effected. The machine will not distinguish between good and poor eyes or no eyes

at all, and as a result seed cut with a machine will usually not give a stand so good as hand-cut seed. Experiments conducted at the North Dakota Agricultural Experiment Station[4] showed that the careful cutting of the tubers, with a slanting cut above the eyes, resulted in a yield of 41.24 bushels above the machine-cut seed. Random cutting by hand likewise gave an increased yield over the machine cut potatoes, amounting to 28.57 bushels per acre. It is readily apparent from these figures that seed carefully cut by hand can be expected to give better results than machine-cut seed.

In some sections of the state, the belief is commonly held that seed-pieces from the seed end of the tuber will outyield those from the stem end. The Maryland Agricultural Experiment Station[5], however, has shown that where seed-pieces of equal weight from the seed and stem ends were planted, the former yielded at the rate of 208 bushels and the latter 216 bushels per acre, a gain of 8 bushels in favor of the seed-pieces from the stem end. They have shown further that this supposed difference in vigor of the two ends of the potatoes was due to the fact that the eyes on the seed end suppressed the growth of the other eyes of the tuber, and if they are removed, the stem eyes are just as capable of producing vigorous shoots as are the eyes on the seed end.

In cutting the seed, care should be taken to cut blocky pieces, as these are not only handled more readily in the planter but they are less likely to rot than long thin pieces. Results obtained at the Maryland station indicate that in cutting tubers for seed, it is advisable to have as many buds near the cut surface as possible, for they will grow out more quickly than those far removed.

Size of Seed-Piece

Within certain limits the yield increases directly with the size of the seed-piece used. In tests conducted in New Jersey, Musgrave[6] found that where a ½-ounce seed-piece was planted the yield was 254.7 bushels per acre, a 1-ounce seed-piece yielded 367.1 bushels, while a 1½-ounce piece gave a yield of 373 bushels. Planted 12 by 32 inches, with seed-pieces averaging ½-ounce in weight 8.5 bushels of seed will be required to plant an acre, 17 bushels with 1-ounce

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[4]Werner, H. O., 1919. Potato Experiments, 1917-18. N. D. Agr. Exp. Sta., Bul. 129.

[5]Appleman, C. O., 1918. Physiological basis for the preparation of potatoes for seed. Md. Agr. Exp. Sta., Bul. 212.

[6]Musgrave, G. W., 1920. What is the most profitable size of a potato seed-piece? New Jersey Agriculture, vol. 11, no. 10.

seed-pieces and 21.3 bushels with 1½-ounce pieces.[7] It is estimated by the United States Bureau of Crop Estimates that the average quantity of seed planted per acre in the United States is 8.6 bushels. In some sections of New Jersey the quantity planted is considerably higher than this. In Monmouth County the average grower plants approximately 14 bushels, in Salem County 10 bushels and in Cumberland County 9 bushels. In some of the other counties the quantity planted is considerably less.

Some growers give more attention to the number of eyes carried by the seed-piece than to its weight. Results of tests to decide the relative importance of the two methods conducted at the North Dakota Agricultural Experiment Station have shown that the weight of the seed-piece is of considerably more importance than is the number of eyes. The net yield per acre above the seed for seed-pieces cut to practically the same weight and with one eye was 223.4 bushels, with two eyes 222.4 and with four eyes 213.2 bushels.

It frequently happens that there are a number of small tubers in the South Jersey late-crop seed, and the question is often raised as to the advisability of planting these whole. A recent publication[8] gives some very interesting figures in this connection. A comparison was made of whole and cut seed with the following results. One-ounce tubers planted whole gave an average of 1.76 stems per hill and 4.25 tubers, 2-ounce tubers halved gave 1.81 stems per hill and 3.99 tubers; 4-ounce tubers quartered gave 1.63 stems per hill and 3.63 tubers. It is apparent that planting the whole tuber showed no increase in the number of stems per hill and produced more tubers and a larger weight of tubers than did the cut seed-piece of the same weight. These same general relations held where the size of the tuber planted was increased to 2 and to 3 ounces.

Too much emphasis cannot be placed upon the importance of the size of the seed-piece. In most cases the New Jersey growers could increase the size of the seed-piece planted to considerable advantage. A carefully cut blocky seed-piece weighing 1 to 1½ ounces should prove very satisfactory under New Jersey conditions.

Treatment of Cut Seed

Where a large acreage is to be planted it is frequently necessary that the seed be cut some time ahead of the planting operations. If the cut seed is properly handled this should not result in any loss of

[7]Stuart, Wm., 1919. Production of late or main crop potatoes. U. S. Dept. Agr., Farmers' Bul. 1064.

[8]Clark, C. F., 1921. Development of tubers in the potato. U. S. Dept. Agr., Bul. 958.

vigor. As soon as the seed is cut it should be dusted with sulfur or land plaster. The former may be of more value for this purpose than the latter but where a two-man planter is used, the latter material will prove to be less objectionable to work with. The presence of either of these materials on the cut surface prevents excessive water loss from the seed-piece. When the cut seed has dried it may be stored in barrels but precautions must be taken to prevent heating. This may be done by turning the seed from one barrel to another every 24 hours.

Fig. 3.—Watch the Planter—See that it is Planting Deep Enough, that the Fertilizer is Delivering Properly and is Well Mixed with the Soil

Care of the cut seed should not end here. Very frequently bags or other containers carrying seed are left standing in the field exposed to the sun for some time, with the result that the seed heats and its vigor is impaired. In other cases the furrow is opened some time before the seed is planted. The soil dries out and the temperature is raised to a point that favors the development of some of the organisms causing rot. Every precaution should be taken to prevent injury to the seed after it is cut; too frequently a poor stand has been attributed to the original seed when it probably resulted from failure to give proper attention to the cut seed.

Planting

Two types of planters are used in New Jersey; the picker type, operated by one man and the two-man planter. The former machine is so built that the seed pieces are taken from the hopper by spikes attached to a revolving wheel and are dropped down a pipe

into the open furrow. The second type of planter is built so that the seed-piece is elevated to a notched, revolving, horizontal disk. A seat is attached to the rear of the machine to provide for a man who sees that each notch carries a single seed-piece. This type of machine usually gives a better stand than the picker type.

Time of Planting

For maximum yields potatoes should be planted as soon as possible after the soil is in good condition. The potato does best in cool soils; where planting is delayed until after the soil has become hot poor germination is likely to result. Early planting also allows for the development of the crop during the cooler months of the summer.

FIG. 4.—CULTIVATE, CULTIVATE, CULTIVATE; START EARLY AND CONTINUE THROUGHOUT THE SEASON

Depth of Planting

The depth to plant is determined to some extent by the nature of the soil. In light sandy soils deficient in humus it is probably advisable that deeper planting be practiced than in heavier soils. For the average potato soil in New Jersey, 2 inches from the surface level will be found satisfactory. To prevent freezing a 3 to 4-inch ridge should be thrown over the row.

Distance of Planting

The distance of planting is determined largely by the fertility of the soil, the moisture supply, and whether or not an early or late variety is to be planted. The Irish Cobbler variety is usually planted 9 to 12 inches in the row with the rows 32 to 33 inches apart. The Green Mountain variety, together with Mill's Pride, Norcross and

other late varieties, is planted 12 inches in the row with the rows 34 to 36 inches apart. The earlier varieties may be planted closer because the vines are usually smaller than those of the late varieties.

Cultivation

The prices paid for vigorous seed and high-grade fertilizer are the most important factors contributing to the cost of growing potatoes. Neither of these will ensure maximum yields, however, if the crop is not cultivated thoroughly and at the right time. Sometimes so large an acreage is planted that it is impossible to cultivate properly, with the result that maximum yields are not obtained.

Fig. 5.—Cultivate Deep and Close to the Young Plants—Thorough Cultivation at this Time Does Much to Insure a Maximum Crop

Cultivation should begin as soon as possible after the crop is planted and should be repeated at frequent intervals throughout the summer. Cultivation tends to decrease the water loss from the soil, prevents the growth of weeds, aerates the soil and keeps it fine, giving the roots a good medium in which to develop.

Successful potato growers in Central Jersey cultivate once a week, starting before the seed sprouts. The first cultivation should be deep, to the bottom of the plowed land if possible. For this operation narrow teeth are used to lighten the draft. The second cultivation is made as soon as the sprouts start and before they are so long as to break easily. After this cultivation, the ridges

are leveled off with a drag harrow or a weeder. The weeder is a necessary tool for successful potato growing, and should be used three or four times before the plants are 6 inches high. In its early use the operator should be careful not to disturb the germinating seed-piece. If the weeder is used properly and at the right time during this stage of the development of the plant, much will be accomplished toward preventing weeds from getting a start in the field, and it will thus save a large amount of hard-hoeing later in the season. As soon as the rows can be distinguished as the plants appear above the ground, the field should be cultivated deep in the center between the rows as well as deep and close to the young plants. This operation should be continued every week. As the plants increase in size, however, it is necessary to cultivate shallow near them so as not to injure the roots but the deep cultivations between the rows should be continued. In the later cultivations it is advisable to examine the teeth of the cultivator at frequent intervals to determine if the roots are being cut. It must be borne in mind that, while thorough and careful cultivation will lead to increased yields, careless cultivation will result in injury.

For the late cultivations it is advisable to adjust the cultivator teeth so as to throw dirt on the row to prevent the development of weeds. Thorough cultivation early in the season will do away with much hand-hoeing later. If weeds and grass make a start, however, it is advisable to hoe them out when the vines begin to meet in the row.

Diseases of the Potato

The potato crop is attacked by a number of diseases, some of them the cause of serious losses. Mention will be made of only the more important of these with the approved measures for their control. A more complete description of all of the diseases of the potato in New Jersey will be found in Circular 122 of the New Jersey Agricultural Experiment Station.

The three principal means of eliminating diseases from the potato crop are: (1) planting clean seed, (2) spraying with Bordeaux mixture, and (3) seed treatment.

Mosaic and leaf roll, two serious diseases of the potato, are responsible for reductions in yield amounting in some instances to as much as 50 per cent of the crop. These diseases are carried in the seed and cannot be controlled by seed treatment or spraying. Control measures must be based on planting clean seed. These diseases have become so prevalent in the important seed-potato growing sections that it is almost impossible to obtain seed entirely free from them.

The buying of certified seed, however, is an assurance to the grower that if these diseases are present the proportion of tubers infected is small.

Scab, rhizoctonia and black leg can be controlled by seed treatment. The latter disease is not of great importance in New Jersey, but the first two mentioned result in considerable losses to the potato crop. Rhizoctonia, or scurf, appears as small black spots on the potato. These black bodies are the resting stage of the fungus, and it is by means of these that the disease is carried over from year to year on the seed potatoes. Seed disinfection with corrosive sublimate as described below kills the fungus and thus prevents infection of the young plant.

Scab is increasing in severity in many sections of the state largely as a result of the practice of planting untreated scabby seed. Where the scab organism is not present in the soil, precautions should be taken to prevent its entrance, and this is best accomplished by seed treatment. For the control of scab either formaldehyde or corrosive sublimate should give good results, but since corrosive sublimate gives better control of rhizoctonia than does formaldehyde, the use of the former is recommended.

Corrosive Sublimate Treatment

Corrosive sublimate (Mercuric chloride)..... 4 oz.
Water .....30 gal.
Treat uncut seed.
Duration of treatment ½ to 1½ hours.

Hot water should be used to dissolve this material. As the solution corrodes metal, it must be prepared and used in wooden containers. Corrosive sublimate is a deadly poison, so the solution must be kept away from children or livestock. Probably the best method to follow in soaking seed potatoes is to treat loose in barrels arranged so that the solution can be drawn off after each lot is treated. In view of the fact that the solution loses strength after treating each lot of potatoes, it is necessary to renew its strength from time to time. The Wisconsin Agricultural Experiment Station[9] has shown that the best plan to follow is to add 3/8 ounce of corrosive sublimate after treating each 4 bushels of potatoes 1½ hours. At the time the chemical is added the solution should be restored to its original volume by the addition of water. If the ½-hour treatment

[9]Brann, J. W., and Vaughan, R. E., 1921. Potato scab. Wis. Agr. Exp. Sta., Bul. 331.

is adopted the amount of chemical added should be reduced to ⅛ ounce.

If no chemical is added the solution should be discarded after using three or four times. Where this is done the duration of the treatment for each consecutive lot should be increased 15 minutes. After the potatoes have been treated they should be spread out so as to dry rapidly.

Formaldehyde Treatment

Formaldehyde ..... 1 pint (pound).
Water .....30 gal.
Treat uncut seed.
Duration of treatment ½ to 1½ hours.

This solution may be used eight or ten times without renewal. The volume should be maintained, however, by the addition of stock solution made up as given above.

The Hot Formaldehyde Treatment

The Iowa Agricultural Experiment Station has developed an improved method of seed treatment that has proved very satisfactory. The method is as follows:

Formaldehyde .....2 pints
Water .....30 gallons

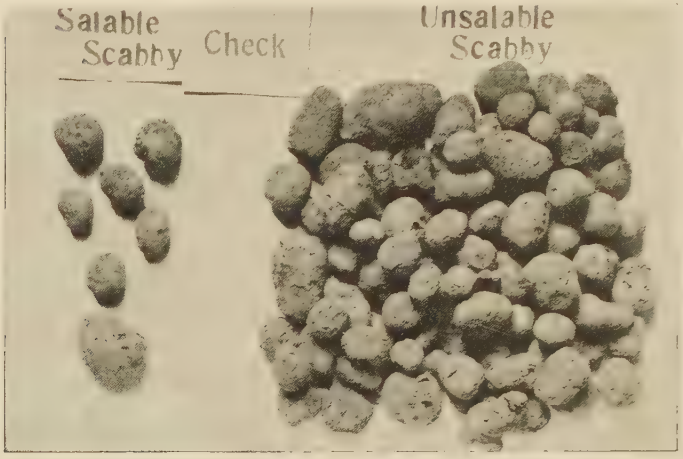
Dip 2 minutes at 118 degrees to 122 degrees F. Pile 6 to 8 inches deep and cover with wet sacks for 60 minutes and then allow to dry.

If this method is adopted the solution should not be allowed to get warmer than 122 degrees, since too hot a solution will injure the tubers. A temperature below 118 degrees will not give satisfactory results. From time to time the solution should be restored to the original volume from a reserve supply. Such replacement will maintain the initial strength.

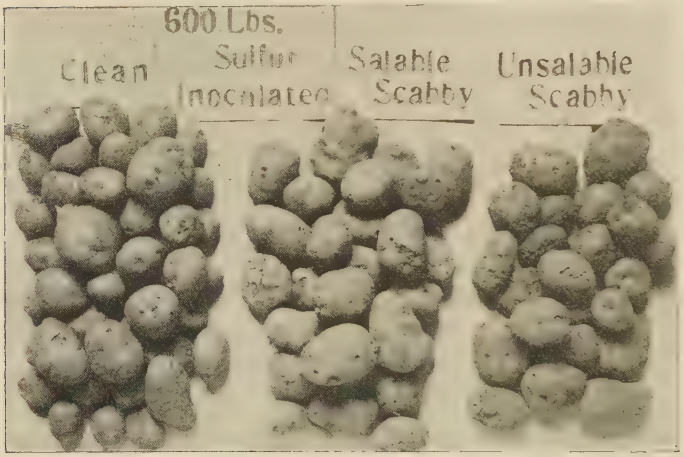
Soil Treatment for Scab

Where the scab organism is present in the soil in large numbers, seed treatment will not control the trouble. Where this condition exists control measures must be such as to inhibit the activities of the organism in the soil. The New Jersey Agricultural Experiment Station has conducted investigations on this question for some time and the results are briefly summarized here. A more complete discussion of this work is to be found in circular 131.

1. The present abundance of scab in the state has resulted from planting untreated scabby seed and in some sections the use of manure from stock fed on scabby tubers. Where scab is not present in the soil, its introduction should be avoided by planting clean seed or seed that has been treated with corrosive sublimate or formaldehyde.



A



B

Fig. 6.—Where the Soil is Heavily Infested with the Scab Organism, Sulfur Has Given Very Good Control; the Tubers Shown in A Were From Plots Receiving no Sulfur, While Those in B Received an Application of 600 Pounds of Inoculated Sulfur Just Before Planting (From New Jersey Agriculture, vol. 2, No. 12)

2. Where there is only a slight amount of scab in the soil, plowing under green manures and the use of acid fertilizers should tend to reduce the trouble.

3. Where a large portion of the crop is unsalable scabby and the farm practice permits, the land should be devoted to growing other crops for a period of years. During this time, the land should be managed in such a way as to promote conditions that will inhibit the activities of the scab

organism. This may be accomplished to a large extent by plowing under green manures, and by the proper choice of fertilizers.

4. Where a large portion of the crop is unsalable and it is necessary to plant the land in potatoes the following year, sulfur has given good results in the control of scab.

5. As the result of a number of experiments the superiority of inoculated sulfur has been demonstrated. The inoculated sulfur not only has given better control of scab, but the indications are that smaller amounts of the inoculated than of the uninoculated may be used to obtain the same results.

6. If restricted areas in the field grow scabby potatoes, sulfur these spots, not the entire field.

7. Where a large portion of the crop is unsalable, 600 pounds of sulfur on a medium to heavy soil should give good control of scab and have little if any injurious effect.

8. Where only a portion of the crop is unsalable, the amount should be reduced to 300 pounds.

9. On the lighter soils, it is questionable if more than 400 pounds of sulfur should be applied.

10. Do not mix sulfur with the fertilizer or apply in the row.

11. The sulfur should be broadcasted with a lime distributor just after the land is plowed and should then be thoroughly harrowed in. In some cases the failure of sulfur to give results may be traced directly to the fact that the application was not made at the proper time.

Spraying Potatoes

Thorough spraying with Bordeaux mixture will control early blight, tip burn and late blight. Early blight and tip burn are usually quite abundant in the state while there have been only three outbreaks of late blight in the past ten years. In 1918 it was quite severe in Mercer, Monmouth and Middlesex counties; and in 1919 there was a slight infection on the commercial crop in these counties with a heavy outbreak on the late crop grown for seed in the southern part of the state. Again in 1920 it was quite severe on the commercial crop in some sections of Monmouth, Mercer and Middlesex counties and on the late crop. In 1921 late blight was not found in the state.

Where late blight is present it is necessary that the crop be sprayed in order to insure a normal yield. Even in the absence of this disease, however, it has been demonstrated that spraying the Irish Cobbler variety will result in increased yields. The results to date with the American Giant variety are not so outstanding.

Preparation of Bordeaux Mixture

As the result of a large number of potato-spraying tests conducted in various sections of the country, the superiority of home-made Bordeaux mixture over that of the commercial mixtures for the

control of late blight and other foliage diseases has been demonstrated. Not only is the home-made mixture more effective but it is cheap and easy to prepare. Bordeaux mixture is a combination of copper sulfate and lime in water. The formula commonly recommended for use for potato spraying is the 5-5-50 mixture (5 pounds

Fig. 7.—Thorough Spraying Pays—Note the Three Nozzles to the Row

of copper sulfate and 5 pounds of lime in 50 gallons of water). While weaker mixtures have been used the indications are that this one will give best results.

If only a small acreage is to be sprayed the mixture may be prepared as needed. Dissolve 5 pounds of copper sulfate in hot water; when completely dissolved make up to 25 gallons. In another container slake 5 pounds of lime and add water to bring the total up to 25 gallons. These two may then be poured together into the spray tank. The spray tank should be equipped with a good strainer, failure to strain the lime-water will frequently result in considerable trouble through the clogging of the nozzles.

When spraying is to be done on a large scale it is advisable to make up stock solutions of copper sulfate and lime. In a separate vessel slake 50 pounds of lime and when it is thoroughly slaked add enough water to make the total up to 50 gallons. In another barrel suspend 50 pounds of copper sulfate in a burlap bag in 50 gallons of water. Adjust the bag so that it

is suspended just beneath the surface of the water. When using the stock solutions 1 gallon represents 1 pound of either of the materials. To make 100 gallons of a 5-5-50 mixture in a 100-gallon spray tank, add 10 gallons (pounds) of the copper sulfate solution while the water is being run into the tank. When the tank is three-quarters full and with the water still running, add 10 gallons (pounds) of the lime-water. When this has been done the tank is filled and the mixture is ready to apply. In making Bordeaux mixture, never pour the undiluted materials together. Always dilute one or both.

How and When to Spray

In all spraying operations the points of importance are: (1) use of the proper mixture, (2) proper machinery, (3) sufficient nozzles,

FIG. 8.—EVERY OTHER FOUR ROWS SPRAYED WITH BORDEAUX MIXTURE
(From Circ. 122, N. J. Agr. Exp. Sta.)

(4) proper nozzle adjustment, (5) proper pressure, and (6) use of sufficient spray material to cover the plants thoroughly.

For successful potato spraying an engine-driven sprayer is not necessary. Horse-drawn traction machines are now on the market that will develop 200 pounds pressure and will give long service. A very important part of any spray machine is the boom; it should be fitted to spray four rows at a time with three nozzles to the row. The drop bars on the boom should be arranged so that they can be readily adjusted to take care of rows of different widths. Pressure also is of extreme importance; for the control of foliage diseases from 150 to 175 pounds will give good results, where plant lice are to be controlled this should be increased to 200-250 pounds.

No definite statement can be made concerning the necessary number of applications. The aim should be to keep the plants covered with a film of Bordeaux mixture. In South Jersey the usual practice is to make four or five applications. In many instances spraying operations are discontinued as soon as the plants begin to meet in the row. This is by no means advisable, as the result of spraying tests conducted the past three years indicate that the late applications are of extreme importance. For the early applications 50 to 75 gallons per acre will probably cover the vines, for later treatments, when the vines are full grown, at least 100 gallons should be applied per acre.

Insects Attacking the Potato

Colorado Potato Beetle

This beetle, which can be readily controlled by keeping the leaf covered with an arsenical compound, usually has two or three generations during the summer. The young larvae, arising from the yellow egg clusters on the under leaf surface, do the most damage, and it is expedient that control measures be undertaken at the time when these larvae appear. The treatment should not be made as soon as the eggs are observed, for when the larvae appear they will go to the plant parts which have developed since the spray application and will escape being poisoned. On the other hand, if the treatment is delayed too long, the larvae not only become active, but as they grow older, they are more difficult to kill.

This beetle may be controlled by the use of either arsenate of lead, calcium arsenate or Paris green. The first two mentioned have an advantage over Paris green in that they contain less soluble arsenic and, as a result, are less likely to burn the leaves. An additional advantage lies in the fact that when applied as a liquid spray, they adhere to the leaf better than Paris green. The majority of the growers in New Jersey apply Paris green as a dust. Except for the tendency to burn, this method is very satisfactory. When applied as a liquid, it should be used at the rate of 2 to 4 pounds to 100 gallons of water. The addition of about 2 pounds of freshly slaked lime will not only reduce the danger of burning to a minimum, but will make it easier to determine if all the leaves are covered. Arsenate of lead or calcium arsenate in the powder form, should be used at the rate of 4 to 6 pounds in 100 gallons of water, the smaller amount being used for the young bugs and the larger quantity for the older ones. When the paste is used, this amount should be doubled. Any of these materials may be used in Bordeaux mixture without the loss of efficiency. The amounts to be used are the same as given above.

FIG. 9.—WATCH THE DIGGER—GET DEEP ENOUGH TO AVOID CUT AND BRUISED POTATOES

FIG. 10.—HARVESTING TIME ON A SOUTH JERSEY POTATO FARM

Flea Beetle

While this beetle is present in more or less abundance throughout the early part of the summer, most serious damage results when the plants are small. None of the known insecticides will poison this insect. The only known method of control lies in covering the leaves with a film of some mixture that will repel the beetle. This can be accomplished by spraying with Bordeaux mixture. Since this insect works on the under leaf surface, it is necessary that the entire plant

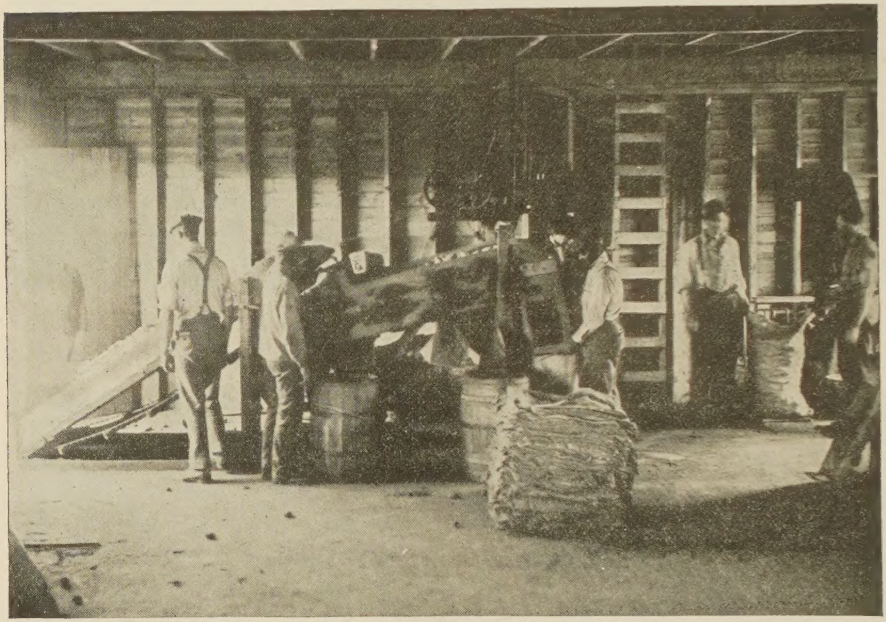


Fig. 11.—Grade the Crop—One of the Important Steps in Potato Growing; The Day of Field-run Stock Has Gone By.

be covered to secure any measure of control. If a liquid sprayer is not available, hydrated lime applied with a good duster will suffice.

Lice

In some sections of the state, serious losses have been experienced during the past several years as a result of heavy infestations of the aphis, or louse. This insect passes the winter in the egg stage, very frequently on the rose or in grass or weeds. In the spring the newly-hatched aphis feed and multiply on the plants on which they overwintered. Some time during the summer a few winged lice appear on the under surface of the potato leaves. They multiply very rapidly, for the young begin to reproduce in about two weeks, hence in a short time an entire field may become infested.

The grower should observe his plants carefully during June and July, and if winged lice surrounded by the greenish-white young are observed, spraying should be started at once. Do not wait until the plants are heavily infested and lying on the ground, for then control measures are practically impossible. Best results will be obtained from the use of 40 per cent nicotine, used at the rate of 1½ pints to 100 gallons of water, to which soap at the rate of 2 to 5 pounds per 100 gallons has been added. Any good laundry soap that is free from resinous matter will be found satisfactory. Nicotine may be added to Bordeaux mixture; when this is done the addition of soap is unnecessary.

Digging the Crop

A large part of the New Jersey crop is dug with the elevator digger. When the elevator is engine-driven two horses are sufficient to draw the digger, otherwise four are necessary. In some sections the digger is drawn by a tractor with very satisfactory results. When the potatoes have been dug they should be picked up as soon as possible after they have dried. If allowed to lie too long in the sun, they will sun-burn and their market value will be diminished. In some instances potatoes are piled in the field and covered with dead vines. This covering affords but little protection from the sun so that the outermost tubers are frequently sun-burned while those at the bottom of the pile rot because of lack of air.

In South Jersey the crop is graded by the pickers in the field. The potatoes are picked in 5/8-bushel baskets and are hauled in these on specially constructed wagon bodies to the loading station. They are usually loaded in bulk, sometimes in bags. In some parts of Central Jersey the tubers are picked in bushel baskets and dumped in bags, in others barrels are used. In all of Central Jersey grading is done by machine, either on the farm or at the loading station. After the potatoes are graded, they are packed in 150-pound bags.

It is probably true that the New Jersey growers pay less attention to grading and standardizing potatoes than any other special crop. The establishment of the United States grades and their adoption by a large number of the New Jersey growers has helped the situation, but there is still room for further improvement. More attention should be given to digging and picking up the crop to prevent unnecessary cuts and bruises. These cut surfaces present a point of entrance for rot organisms and otherwise injure the market value of the crop. More care, likewise, should be exercised in grading, as carelessness in this operation frequently leads to many cut and bruised potatoes.